3D Remapping on Unstructured Meshes for ALE Simulations

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Most ALE (Arbitrary Lagrangian-Eulerian) methods require a general, accurate and efficient algorithm for conservative function interpolation (remapping) to transfer information from Lagrangian grid to rezoned grid. We want this interpolation to be accurate, conservative and monotonicity preserving. To achieve high-order of accuracy of interpolation, we use the piecewise linear reconstruction of functions on the Lagrangian grid and then integrate over the cells of the modified grid.

In 1D the situation is easy, all methods are fast enough on today's computers and we can choose from methods with the best properties.

In 2D the situation is much more complex and we have much more work to do with developing such an algorithm. The most natural method for computation of mean values on the new grid based by exact integration is very slow; we developed a much faster based on swept area integration (swept area is the region created by moving one cell edge from the original grid to the edge of the new grid). It satisfies our requirements and it is much faster. The method is described in [1].

This summer I worked on generalization of this algorithm to general 3D unstructured meshes. In 3D the natural exact integration is almost unusable because of the huge time expense of the computation. In the generalization of our swept area integration to 3D we developed several tools for working with general polyhedrons. We implemented this algorithm using MSTK (MeSh ToolKit) library, which provides general framework for representing general arbitrary polyhedral meshes [2]. Special care is taken about the routine for integration of linear function over arbitrary polyhedron [3], which makes this algorithm face-based and efficient.

Our remapping algorithm is applicable to unstructured ALE hydrodynamical code.

References

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